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# UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No.	TI-28043
First Named Inventor or Application Identifier	Danke Mahesh Bhaskar
Title	Method for Enhancing Rendering of Picture Elements
Express Mail Label No.	EL 547745116US

## APPLICATION ELEMENTS

See MPEP Chapter 600 concerning utility patent application contents

## ADDRESS TO:

Assistant Commissioner for Patents  
Box Patent Application  
Washington, DC 20231

1. ☒ \*Fee Transmittal Form (e.g., PTO/SB/17)  
(Submit an original, and a duplicate for fee processing)
2. ☒ Specification [Total Pages **12**]  
(preferred arrangement set forth below)
  - Descriptive title of the invention
  - Cross References to Related Applications
  - Statement Regarding Fed sponsored R&D
  - Reference to Microfiche Appendix
  - Background of the invention
  - Brief Summary of the invention
  - Brief Description of the Drawings (if filed)
  - Detailed Description
  - Claim(s)
  - Abstract of the Disclosure
3. ☒ Drawing(s) (35 USC d113) [Total Sheets **2**]
4. Oath or Declaration [Total Pages **1**]
  - a. ☒ Newly Executed (original or copy)
  - b. ☐ Copy from a prior application (37 CFR §1.63(d))  
(for continuation/divisional with Box 17 completed)

**[Note Box 5 below]**

- i. ☐ **DELETION OF INVENTOR(S)**  
Signed statement attached deleting inventor(s)  
named in the prior application,  
see 37 CFR §1.63(d)(2) and 1.33(b)
5. ☐ Incorporation By Reference (useable if Box 4b is checked)  
The entire disclosure of the prior application, from which a copy of  
the oath or declaration is supplied under Box 4b, is considered as  
being part of the disclosure of the accompanying application and is  
hereby incorporated by reference therein.

6. ☐ Microfiche Computer Program (Appendix)
7. ☐ Nucleotide and/or Amino Acid Sequence Submission  
(if applicable, all necessary)
  - a. ☐ Computer Readable Copy
  - b. ☐ Paper Copy (identical to computer copy)
  - c. ☐ Statement verifying identical of above copies

## ACCOMPANYING APPLICATION PARTS

8. ☒ Assignment Papers (cover sheet & Documents(s))
9. ☐ 37 CFR §3.73(b) Statement (when there is an assignee) ☒ Power of Attorney
10. ☐ English Translation Document (if applicable)
11. ☐ Information Disclosure Statement (IDS)/PTO-1449 ☐ Copies of IDS Citations
12. ☒ Preliminary Amendment
13. ☒ Return Receipt Postcard (MPEP 503)  
(Should be specifically itemized)
14. ☐ \*Small Entity Statement(s) ☐ Statement filed in prior application  
(PTO/SB/09-12) Status still proper and desired
15. ☐ Certified Copy of Priority Document(s)  
(if foreign priority is claimed)
16. ☐ Other:

\*A new statement is required to be entitled to pay small entity fees, except where one has been filed in a prior application and is being relied upon.

17. If a CONTINUING APPLICATION, check appropriate box and supply the requisite information below and in a preliminary amendment:

☐ Continuation ☐ Divisional ☐ Continuation-in-part (CIP) of prior application No: \_\_\_\_\_  
Prior application information: Examiner \_\_\_\_\_ Group / Art Unit: \_\_\_\_\_

## 18. CORRESPONDENCE ADDRESS

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Signature

*Robert L. Troike*

Date

7/14/00

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of:

TI-28043

Danke Mahesh Bhaskar

Examiner: TBD

Serial No: TBD

Art Unit: TBD

Filed: Herewith

For: Method for Enhancing Rendering of Picture Elements

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents

Washington, D. C. 20231

Dear Sir:

"EXPRESS MAILING" Mailing Label No. EL547745116US I hereby certify that this paper is being deposited with the U.S. Postal Service Express Mail Post Office to Addressee Service under 37 CFR 1.10 on the date shown below and is addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231.

*Robert L. Troike*

Robert L. Troike, Reg. No. 24,183

*7/14/00*  
Date

This application claims priority under 35 USC 119 (e)(1) of provisional application number 60/149,356, filed 08/18/99.

Prior to the examination of the above-identified application, please amend the specification by inserting before the first line the sentence:

--This application claims priority under 35 USC § 119(e)(1) of provisional application number 60/149,356, filed 08/18/99.--

Respectfully submitted,

*Robert L. Troike*

Robert L. Troike  
Attorney for Applicant  
Reg. No. 24,183

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Fax: (202) 639-7890

# METHOD FOR ENHANCING RENDERING OF PICTURE ELEMENTS

## 5 Copyright Authorization

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## 10 FIELD OF INVENTION

This invention relates to enhancing the rendering of picture elements or pixels and more particularly to the rendering of pixels using computer operation codes or opcodes.

## 15 BACKGROUND OF INVENTION

Today graphical pictures may be printed or displayed on a raster scan screen. The pictures may be computer generated or may be otherwise generated and then scanned by an electronic graphic  
20 scanner that converts an image into a video raster graphic image. The smallest element on such a screen or printer is a pixel or picture element.

The present invention relates to raster image processing software used in printer or screen controllers. The raster image processing (RIP) in computer graphics is the component (hardware,

software or both) that prepares data for raster output (screen or printer). The software operation codes or opcodes is that part of the machine instruction that tells the computer what to do. The whole task of printing can be divided into the two subtasks of interpretation and rendering.

Out of the total processing time interpretations takes about 20 percent of the time whereas rendering takes around 80 percent of the time. During interpretations each line of source language is translated into machine language and then executed. In rendering, a 3-D image is created that incorporate the simulation of lighting effects, such as shadows and reflection.

The shading operation code (opcode) is one of the many opcodes which constitutes rendering subsystems. While using the software packages like Adobe Illustrator of Adobe Systems, Inc., Mountain View, CA, the programmer draws an arbitrary figure and chooses the type of shading to generate the special effects. The Adobe system uses PostScript (a page description language) commands. These commands are language statements in ASCII text that are translated into a printer machine language by a PostScript interpreter built into the printer. When a Postscript file is submitted to a printer, during interpretation stage, this arbitrary figure is divided into graphics rendering primitives where the gray value at each and every pixel is a linear or nonlinear function of its position in the primitive. A primitive is a graphic element such as a point, line, arc, cone or sphere used as a building block for creating images.

To optimize the performance, the nonlinear function is represented by a lookup table with predefined values in an array, matrix, etc. or within a data file. The index into the lookup table is calculated for every pixel using the base value and the gradient in both x and y directions as well as the position of the pixel in the primitive. Sometimes the index does not fall into the lookup table

because of precision problems associated with the computations or may be due to the nonlinear nature of the function associated with it.

The core loop of the opcode should have two boundary checks for the index to avoid accessing outside the lookup table area. These checks introduce additional instructions and hence  
5 increases the time taken for rendering one pixel.

It is desirable to provide a method for reducing the time take for rendering each and every pixel in the case of shading opcodes.

## SUMMARY OF INVENTION

In accordance with one embodiment of the present invention for a given opcode table, maximum and minimum values of index are determined and the lookup table is expanded in both  
5 directions to take care of these maximum and minimum values and the checks in the core loop are removed, reducing the total rendering clock count.

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## **DESCRIPTION OF DRAWINGS:**

In the drawings:

Figure 1 is a diagram of the system according to one embodiment of the  
5 present invention;

Figure 2 is a flow chart of the steps in RIP;

Figure 3 illustrates rendering function;

Figure 4 illustrates a typical function and lookup table indexing; and

Figure 5 illustrates lookup table expansion.

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## DESCRIPTION OF PREFERRED EMBODIMENTS OF THE PRESENT INVENTION

Referring to Fig. 1 there is illustrated a diagram of the system according to one embodiment of the present invention. A programmer (user) draws an arbitrary figure at a computer terminal 11 that is connected via connector lead 13 to a raster output device such as a printer 15. The programmer chooses the type of shading to generate special 3-D image effects. The printer or screen 15 includes a controller 17. The controller 17 includes a raster image processor (RIP) 18 that prepares the data for the raster output. The RIP processor 18 includes software. The RIP software includes, for example, a page description language like Postscripts as in Adobe Illustrator of Adobe Systems. Postscripts level - 3 supports different types of shading like radial and axial shading and also supports linear and nonlinear (based on some function) shading. The RIP software has the two main tasks of interpretation and rendering.

During the interpretation stage (step 21 in Fig. 2) the drawn figure is divided into graphic primitives where the grey value at each and every pixel is a linear or nonlinear functions of its position in the primitive. The second step is rendering (Step 23 in Fig 2.). In rendering, a 3-D image is created that incorporate the simulation of lighting effects. For the non-linear function (Step 25), an index into a lookup table (19 in Fig. 1) is generated in generator 18 (Fig. 1 ) by using the initial grey value and the rate of change along both x and y axes. The lookup table 19 is given for a range of index values, but the maximum and minimum values of the index may cover a larger range (may be due to the precision problems that generates them). If the index for the particular pixel does not fall into the lookup, the pixel is rendered with grey value given by closest boundary index. For the



present case, lookup table 19 will be given for 0 to 255 index values, whereas the minimum to maximum values of the index will be -255 to 511.

The following are the inputs given for a graphics primitive to be rendered.

1. Init\_value: The initial index value of a graphics primitive.
2. Delta\_x: Rate of change of index value along the x axis.
3. Delta\_y: Rate of change of index value along the y axis.
4. Look up table with 256 values representing a complex function.

Referring to Fig. 3 there is illustrated the rendering function.

The index value at A = Init\_value

The index value at B = Init\_value + Delta\_x \*(x2-x1)

The index value at C = Init\_value + Delta\_y \*(y2-y1)

The lookup table 19 can represent any complex function and if the index does not fall into the lookup table range, the pixel is rendered with the grey value corresponding to the closest boundary index as shown in Fig. 4. As shown in Fig. 4 an index of -232 is the same as index 0 and an index of 500 is the same as index 255.

In the prior art, the following operations are implemented.

1. Calculate the index depending upon joint value and Deltas in both x and y directions.
2. Compare the index with zero. If it is less than zero the index is equal to zero.
3. Similarly compare the index with 255. If it is more than 255 it is kept at 255.

4. Using the index value get the grey value from the lookup table and render the given pixel.

The implementation of this approach in operations in assembly code requires about 4-5 clocks for each pixel.

5 In accordance with the present invention for a given lookup table, maximum and minimum values of index values are determined as illustrated by step 27 in Fig.2. The lookup table is expanded in both directions to take care of these maximum and minimum values as illustrated by step 29 in Fig. 2. The checks in the core loop are removed. This reduces the total rendering clock count.

10 In the embodiment presented above the lookup table is expanded to take care of this maximum range of -255 to 512. As illustrated in Fig. 5 the value at index 0 is replicated from -1 to -255 index values and the value at index 255 is replicated from 256 to 511 index values.

The core loop written in algebraic assembly language for, Texas Instruments TMS 320 C82 DSP processor is as follows:

15 START\_LINE\_X:  
LX1 = Gray\_value>>16  
|| temp =b \*(La\_look\_up + [LX1])  
END\_LINE\_X:  
\*La\_band\_buffer++=b temp  
20 ||Gray\_value=Gray\_value + Delta\_X  
.cjump START\_LINE\_X

The core loop takes exactly two clocks.

This approach takes 2 clocks where existing approach takes around 4-5 clocks for rendering a simple pixel.

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**IN THE CLAIMS:**

1. A method of enhancing the rendering of pixels in the case of opcode comprising the steps of:

5 determining maximum and minimum values of index, and expanding the lookup table opcodes over all values of index.

2. The method of Claim 1 wherein the expanding step includes the step of replicating the highest value if the index is above the normal table area.

3. The method of Claim 1 wherein said opcodes are for shading.

10 4. The method of Claim 1 wherein the expanding step includes the step of replicating the lowest value if the index is below the normal table area.

5. A printer comprising:

a printing device,

15 a printer controller for controlling said printing device, said printer controller including means for interpreting responsive to each line of source language to translate into machine language and then execute and wherein a figure to be printed is divided into graphics rendering primitives and means for rendering where each and every pixel in the primitive is a function of its position the primitive, said means for rendering includes a lookup table that includes opcode values over all values of indexes wherein the index into the lookup table is calculated for every pixel using a base  
20 value and a gradient in both x and y directories.

6. A raster image processor for preparing data for raster output comprising:

an interpreter for translating source language into machine language  
and dividing figure drawn into primitives,

a rendering subsystem including a means for generating an index for each pixel in each of  
said primitives and

5 a lookup table for the entire range of index values.

7. The raster image processor of Claim 6 wherein said lookup table of said rendering  
subsystem has its highest and lowest values replicated above and below the normal table indexes so  
as to provide lookup table values for the entire range of indexes.

## ABSTRACT

For a given lookup table ,maximum and minimum values of index values are determined. The lookup table is expanded in both directions by replicating the lowest and highest values to take care  
5 of these maximum and minimum values. This reduces the rendering clock count for each pixel.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of

Danke Mahesh Bhaskar

Serial No.: TBD

Filed: Herewith

For: Method for Enhancing Rendering of Picture Elements

TI-28043

Examiner: TBD


Art Unit: TBD

LETTER TO THE OFFICIAL DRAFTSPERSON

Assistant Commissioner for Patents

Washington, D.C. 20231


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 7/14/60  
Robert L. Troike, Reg. No. 24, 183 Date

Sir:

Enclosed are **TWO (2)** sheets of formal drawings for the above-referenced case. Please charge any necessary fees to Deposit Account No. 20-0668 of Texas Instruments Incorporated. This sheet is enclosed in triplicate.

Respectfully submitted,



Robert L. Troike  
Attorney for Applicant  
Reg. No. 24,183

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Dallas, TX 75265  
(202) 639-7710

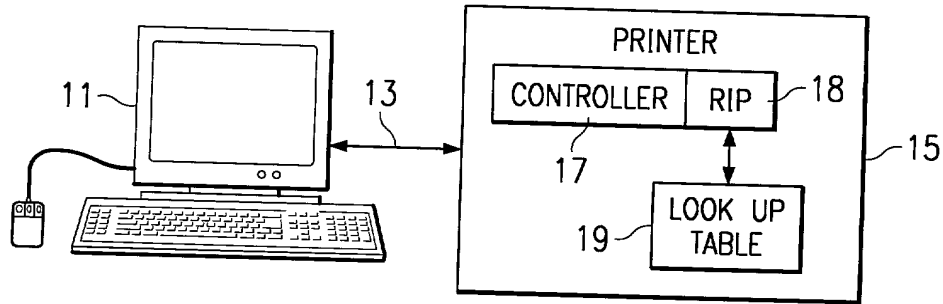


FIG. 1

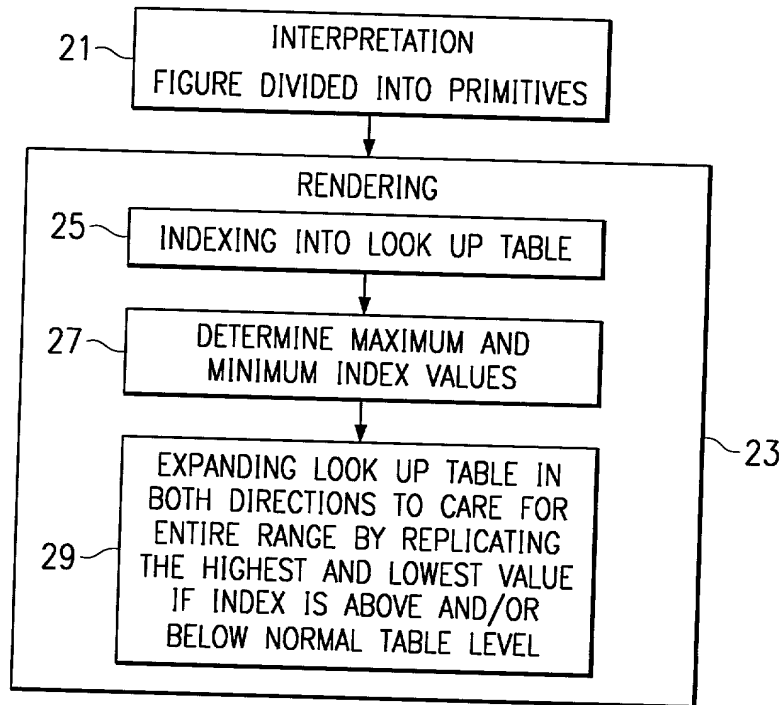


FIG. 2

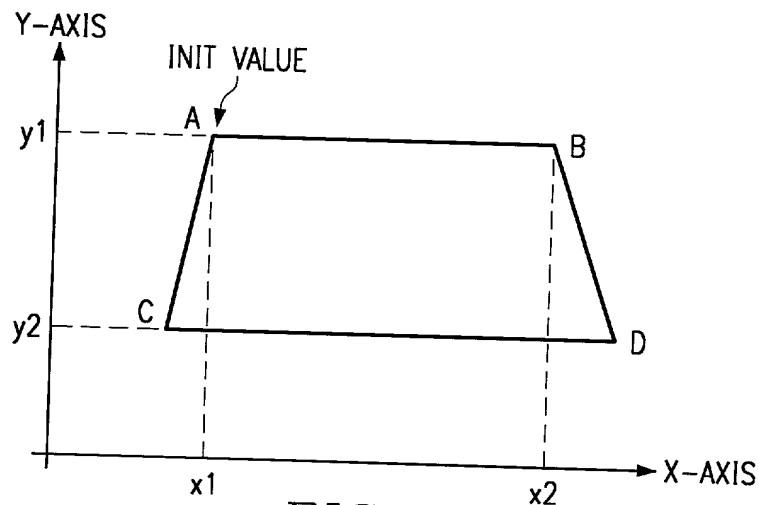


FIG. 3



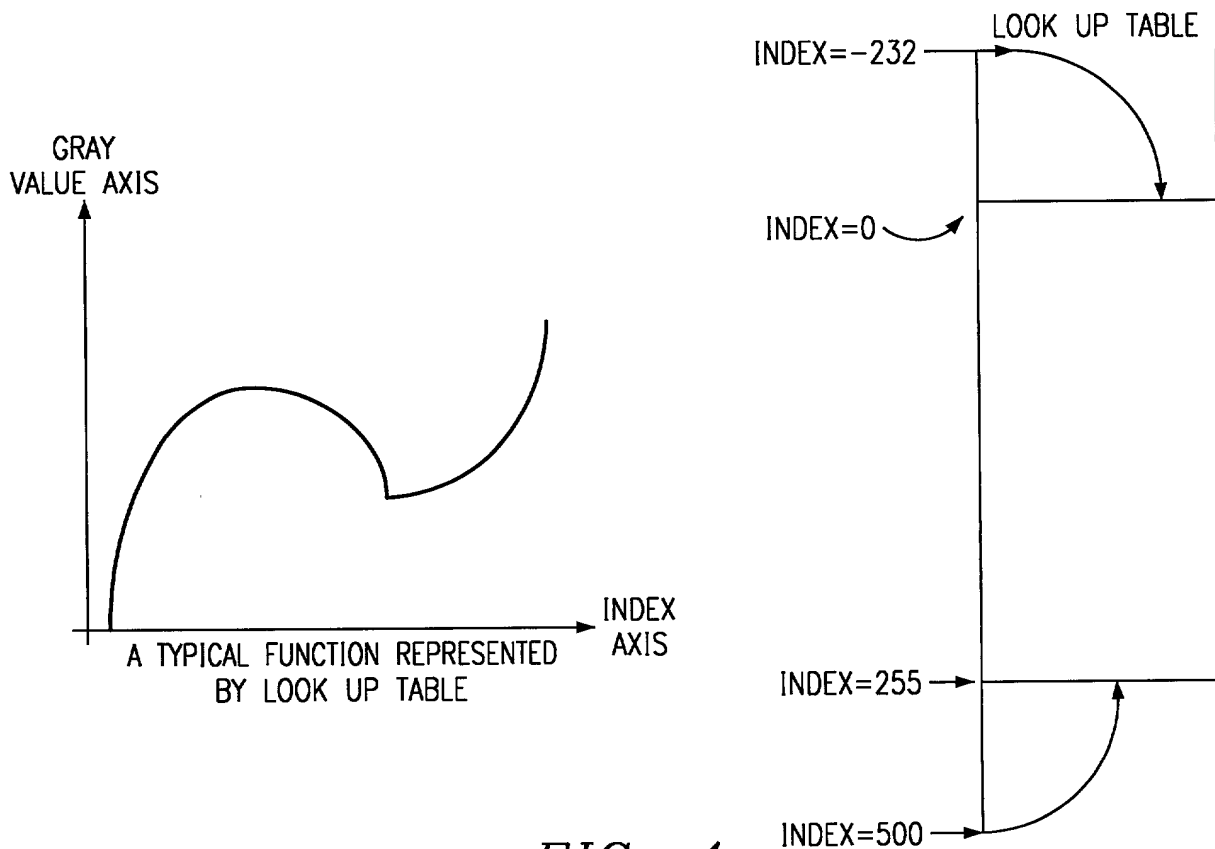


FIG. 4

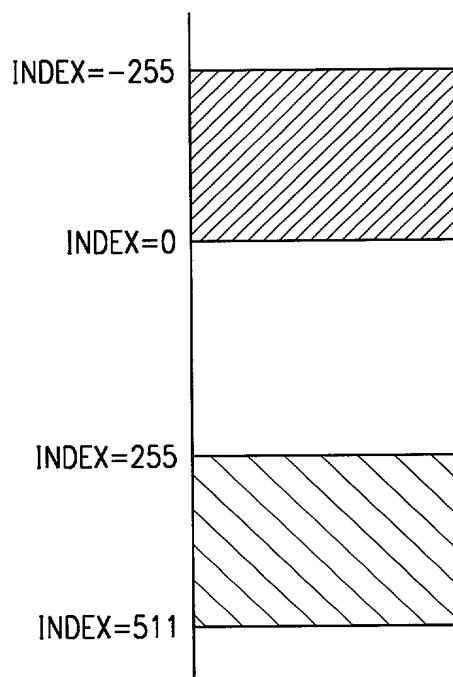



FIG. 5

**APPLICATION FOR UNITED STATES PATENT**  
**DECLARATION AND POWER OF ATTORNEY**

As a below named inventor, I declare that my residence, post office address and citizenship are as stated below next to my name; that I verily believe that I am the original, first and sole inventor if only one name is listed below, or an original, first and joint inventor if plural inventors are named below, of the subject matter which is claimed and for which a patent is sought on the invention entitled as set forth below, and the title as set forth below which is described in the attached specification; that I have reviewed and understand the contents of the specification, including the claims, as amended by any amendment specifically referred to in the oath or declaration; that no application for patent or inventor's certificate on this invention has been filed by me or my legal representatives or assigns in any country foreign to the United States of America prior to the filing date of said application; and that I acknowledge my duty to disclose information which is material to the patentability of this application in accordance with Title 37, Code of Federal Regulations, section 1.56;

I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

TITLE OF INVENTION: Method for Enhancing Rendering of Picture Elements		
POWER OF ATTORNEY: I HEREBY APPOINT THE FOLLOWING ATTORNEYS TO PROSECUTE THIS APPLICATION AND TRANSACT ALL BUSINESS IN THE PATENT AND TRADEMARK OFFICE CONNECTED THEREWITH Robert L. Troike, #24,183; Richard L. Donaldson, #25,673; Jay M. Cantor, #19,906; Lawrence J. Bassuk, #29,043; William B. Kempner, Reg. No. 28,228; Carlton H. Hoel, #29,934		
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COUNTRY OF CITIZENSHIP: India	COUNTRY OF CITIZENSHIP:	COUNTRY OF CITIZENSHIP:
SIGNATURE OF INVENTOR: 	SIGNATURE OF INVENTOR:	SIGNATURE OF INVENTOR:
DATE: 23rd Aug 99.	DATE:	DATE: